

# THE BELL SYSTEM TECHNICAL JOURNAL

A JOURNAL DEVOTED TO THE  
SCIENTIFIC AND ENGINEERING  
ASPECTS OF ELECTRICAL  
COMMUNICATION

## EDITORIAL BOARD

---

BANCROFT GHERARDI

A. F. DIXON

D. LEVINGER

H. P. CHARLESWORTH

O. E. BUCKLEY

M. J. KELLY

W. WILSON

F. B. JEWETT

O. B. BLACKWELL

H. S. OSBORNE

R. W. KING, *Editor*

J. O. PERRINE, *Associate Editor*

## TABLE OF CONTENTS AND INDEX

VOLUME XVI

1937

AMERICAN TELEPHONE AND TELEGRAPH COMPANY  
NEW YORK

PRINTED IN U. S. A.

151

# THE BELL SYSTEM TECHNICAL JOURNAL

VOLUME XVI, 1937

## Table of Contents

### JANUARY, 1937

A Million-Cycle Telephone System— <i>M. E. Strieby</i> .....	1
A Power Amplifier for Ultra-High Frequencies— <i>A. L. Samuel and N. E. Sowers</i> .....	10
The Physical Reality of Zenneck's Surface Wave— <i>W. Howard Wise</i> .....	35
Radio Propagation Over Plane Earth—Field Strength Curves— <i>Charles R. Burrows</i> .....	45
The Inductive Coordination of Common-Neutral Power Distribution Systems and Telephone Circuits— <i>J. O'R. Coleman and R. F. Davis</i> .....	76
Series for the Wave Function of a Radiating Dipole at the Earth's Surface— <i>S. O. Rice</i> .....	101
Technical Digest— Currents and Potentials along Leaky Ground-Return Conductors— <i>E. D. Sunde</i> .....	110

### APRIL, 1937

Recent Trends in Toll Transmission in the United States— <i>Edwin H. Colpitts</i> .....	119
Crosstalk Between Coaxial Transmission Lines— <i>S. A. Schelkunoff and T. M. Odarenko</i> .....	144
Sound Recording on Magnetic Tape— <i>C. N. Hickman</i> .....	165
Constant Resistance Networks with Applications to Filter Groups— <i>E. L. Norton</i> .....	178
A Laboratory Evaluation of Wood Preservatives— <i>R. E. Waterman, John Leutritz and Caleb M. Hill</i> .....	194
Study of Magnetic Losses at Low Flux Densities in Permalloy Sheet— <i>W. B. Ellwood and V. E. Legg</i> .....	212
Moisture in Textiles— <i>Albert C. Walker</i> .....	228

JULY, 1937

Scientific Research Applied to the Telephone Transmitter and Receiver— <i>Edwin H. Colpitts</i> .....	251
The Use of Coaxial and Balanced Transmission Lines in Filters and Wide-Band Transformers for High Radio Frequencies— <i>W. P. Mason and R. A. Sykes</i> .....	275
A Ladder Network Theorem— <i>John Riordan</i> .....	303
Contemporary Advances in Physics, XXXI—Spinning Atoms and Spinning Electrons— <i>Karl K. Darrow</i> .....	319
A Multiple Unit Steerable Antenna for Short-Wave Reception— <i>H. T. Friis and C. B. Feldman</i> .....	337

OCTOBER, 1937

Resistance Compensated Band-Pass Crystal Filters for Use in Unbalanced Circuits— <i>W. P. Mason</i> .....	423
Magnetic Generation of a Group of Harmonics— <i>E. Peterson, J. M. Manley and L. R. Wrathall</i> .....	437
The Vodas— <i>S. B. Wright</i> .....	456
Radio Telephone Noise Reduction by Voice Control at Receiver— <i>C. C. Taylor</i> .....	475
Transmitted Frequency Range for Circuits in Broad-Band Systems— <i>H. A. Affel</i> .....	487
The Dielectric Properties of Insulating Materials— <i>E. J. Murphy and S. O. Morgan</i> .....	493
Variable Frequency Electric Circuit Theory with Application to the Theory of Frequency-Modulation— <i>John R. Carson and Thornton C. Fry</i> .....	513
Irregularities in Broad-Band Wire Transmission Circuits— <i>Pierre Mertz and K. W. Pfleger</i> .....	541
Technical Digests— Transoceanic Radio Telephone Development— <i>Ralph Bown</i> .....	560
A Negative Grid Triode Oscillator and Amplifier for Ultra-High Frequencies— <i>A. L. Samuel</i> .....	568
Addendum— Radio Propagation over Plane Earth—Field Strength Curves— <i>C. R. Burrows</i> .....	574

## Index to Volume XVI

### A

- Affel, H. A.*, Transmitted Frequency Range for Circuits in Broad-Band Systems, page 487.  
 Amplifier for Ultra-High Frequencies, A Power, *A. L. Samuel and N. E. Sowers*, page 10.  
 Amplifier for Ultra-High Frequencies, A Negative Grid Triode Oscillator and (a Digest), *A. L. Samuel*, page 568.  
 Antenna for Short-Wave Reception, A Multiple Unit Steerable, *H. T. Friis and C. B. Feldman*, page 337.

### B

- Bowen, Ralph*, Transoceanic Radio Telephone Development (a Digest), page 560  
*Burrows, Charles R.*, Radio Propagation Over Plane Earth—Field Strength Curves, page 45.  
 Addendum to "Radio Propagation Over Plane Earth—Field Strength Curves," page 574.  
 Broad-Band Systems, Transmitted Frequency Range for Circuits in, *H. A. Affel*, page 487.  
 Broad-Band Wire Transmission Circuits, Irregularities in, *P. Mertz and K. W. Pfleger*, page 541.

### C

- Carson, John R. and Thornton C. Fry*, Variable Frequency Electric Circuit Theory with Application to the Theory of Frequency Modulation, page 513.  
 Circuit Theory, Variable Frequency Electric, with Application to the Theory of Frequency Modulation, *John R. Carson and Thornton C. Fry*, page 513.  
 Circuits in Broad-Band Systems, Transmitted Frequency Range for, *H. A. Affel*, page 487.  
 Coaxial: Irregularities in Broad-Band Wire Transmission Circuits, *P. Mertz and K. W. Pfleger*, page 541.  
 Coaxial: A Million-Cycle Telephone System, *M. E. Strieby*, page 1.  
 Coaxial Transmission Lines, Crosstalk Between, *S. A. Schelkunoff and T. M. Odarenko*, page 144.  
 Coaxial and Balanced Transmission Lines in Filters and Wide-Band Transformers for High Radio Frequencies, The Use of, *W. P. Mason and R. A. Sykes*, page 275.  
*Coleman, J. O'R. and R. F. Davis*, The Inductive Coordination of Common-Neutral Power Distribution Systems and Telephone Circuits, page 76.  
*Colpitts, Edwin H.*, Recent Trends in Toll Transmission in the United States, page 119.  
 Scientific Research Applied to the Telephone Transmitter and Receiver, page 251.  
 Contemporary Advances in Physics, XXXI—Spinning Atoms and Spinning Electrons, *Karl K. Darrow*, page 319.  
 Crosstalk Between Coaxial Transmission Lines, *S. A. Schelkunoff and T. M. Odarenko*, page 144.  
 Crystal Filters for Use in Unbalanced Circuits, Resistance Compensated Band-Pass, *W. P. Mason*, page 423.  
 Cycle, A Million-, Telephone System, *M. E. Strieby*, page 1.

### D

- Davis, R. F. and J. O'R. Coleman*, The Inductive Coordination of Common-Neutral Power Distribution Systems and Telephone Circuits, page 76.

- Darrow, Karl K.*, Contemporary Advances in Physics, XXXI—Spinning Atoms and Spinning Electrons, page 319.  
*Dielectric Properties of Insulating Materials, The, E. J. Murphy and S. O. Morgan*, page 493.

E

- Electric Circuit Theory, Variable Frequency, with Application to the Theory of Frequency Modulation, *John R. Carson and Thornton C. Fry*, page 513.  
*Ellwood, W. B. and V. E. Legg*, Study of Magnetic Losses at Low Flux Densities in Permalloy Sheet, page 212.

F

- Feldman, C. B. and H. T. Friis*, A Multiple Unit Steerable Antenna for Short-Wave Reception, page 337.  
 Filter Groups, Constant Resistance Networks with Applications to, *E. L. Norton*, page 178.  
 Filters, Resistance Compensated Band-Pass Crystal, for Use in Unbalanced Circuits, *W. P. Mason*, page 423.  
 Filters and Wide-Band Transformers for High Radio Frequencies, The Use of Coaxial and Balanced Transmission Lines in, *W. P. Mason and R. A. Sykes*, page 275.  
 Frequencies, Ultra-High, A power Amplifier for, *A. L. Samuel and N. E. Sowers*, page 10.  
 Frequency Modulation, Variable Frequency Electric Circuit Theory with Application to the Theory of, *John R. Carson and Thornton C. Fry*, page 513.  
 Frequencies, Ultra-High, A Negative Grid Triode Oscillator and Amplifier for (a Digest), *A. L. Samuel*, page 568.  
*Friis, H. T. and C. B. Feldman*, A Multiple Unit Steerable Antenna for Short-Wave Reception, page 337.  
*Fry, T. C. and J. R. Carson*, Variable Frequency Electric Circuit Theory with Application to the Theory of Frequency Modulation, page 513.

G

- Ground-Return Conductors, Leaky, Currents and Potentials along (a Digest), *E. D. Sunde*, page 110.

H

- Hickman, C. N.*, Sound Recording on Magnetic Tape, page 165.  
*Hill, Caleb M., R. E. Waterman and John Leutritz*, A Laboratory Evaluation of Wood Preservatives, page 194.

I

- Insulating Materials, The Dielectric Properties of, *E. J. Murphy and S. O. Morgan*, page 493.

L

- Legg, V. E. and W. B. Ellwood*, Study of Magnetic Losses at Low Flux Densities in Permalloy Sheet, page 212.  
*Leutritz, John, R. E. Waterman and Caleb M. Hill*, A Laboratory Evaluation of Wood Preservatives, page 194.

M

- Magnetic Generation of a Group of Harmonics, *E. Peterson, J. M. Manley and L. R. Wrathall*, page 437.  
 Magnetic Losses at Low Flux Densities in Permalloy Sheet, Study of, *W. B. Ellwood and V. E. Legg*, page 212.  
 Magnetic Tape, Sound Recording on, *C. N. Hickman*, page 165.  
*Manley, J. M., E. Peterson and L. R. Wrathall*, Magnetic Generation of a Group of Harmonics, page 437.

- Mason, W. P., Resistance Compensated Band-Pass Crystal Filters for Use in Unbalanced Circuits, page 423.  
 Mason, W. P. and R. A. Sykes, The Use of Coaxial and Balanced Transmission Lines in Filters and Wide-Band Transformers for High Radio Frequencies, page 275.  
 Mertz, P. and K. W. Pfleger, Irregularities in Broad-Band Wire Transmission Circuits page 541.  
 Moisture in Textiles, Albert C. Walker, page 228.  
 Morgan, S. O. and E. J. Murphy, The Dielectric Properties of Insulating Materials, page 493.  
 Murphy, E. J. and S. O. Morgan, The Dielectric Properties of Insulating Materials, page 493.

N

- Network Theorem, A Ladder, John Riordan, page 303.  
 Networks, Constant Resistance, with Applications to Filter Groups, E. L. Norton, page 178.  
 Noise Reduction, Radio Telephone, by Voice Control at Receiver, C. C. Taylor, page 475.  
 Norton, E. L., Constant Resistance Networks with Applications to Filter Groups, page 178.

O

- Odarenko, T. M. and S. A. Schelkunoff, Crosstalk between Coaxial Transmission Lines, page 144.  
 Oscillator and Amplifier, A Negative Grid Triode, for Ultra-High Frequencies (a Digest), A. L. Samuel, page 568.

P

- Permalloy Sheet, Study of Magnetic Losses at Low Flux Densities in, W. B. Ellwood and V. E. Legg, page 212.  
 Peterson, E., J. M. Manley and L. R. Wrathall, Magnetic Generation of a Group of Harmonics, page 437.  
 Pfleger, K. W. and P. Mertz, Irregularities in Broad-Band Wire Transmission Circuits, page 541.  
 Physics, XXXI, Contemporary Advances in—Spinning Atoms and Spinning Electrons, Karl K. Darrow, page 319.  
 Power Distribution Systems, Common-Neutral, and Telephone Circuits, The Inductive Coordination of, J. O'R. Coleman and R. F. Davis, page 76.

R

- Radio Frequencies, High, The Use of Coaxial and Balanced Transmission Lines in Filters and Wide-Band Transformers for, W. P. Mason and R. A. Sykes, page 275.  
 Radio Telephone Development, Transoceanic (a Digest), Ralph Bown, page 560.  
 Radio Telephone Noise Reduction by Voice Control at Receiver, C. C. Taylor, page 475.  
 Radio Propagation over Plane Earth—Field Strength Curves, Charles R. Burrows, page 45; Addendum to, page 574.  
 Radio: A Power Amplifier for Ultra-High Frequencies, A. L. Samuel and N. E. Sowers, page 10.  
 Radio: A Negative Grid Triode Oscillator and Amplifier for Ultra-High Frequencies (a Digest), A. L. Samuel, page 568.  
 Radio: A Multiple Unit Steerable Antenna for Short-Wave Reception, H. T. Friis and C. B. Feldman, page 337.  
 Radio: Series for the Wave Function of a Radiating Dipole at the Earth's Surface, S. O. Rice, page 101.  
 Radio: The Vodas, S. B. Wright, page 456.  
 Radio: The Physical Reality of Zenneck's Surface Wave, W. Howard Wise, page 35.  
 Receiver, Scientific Research Applied to the Telephone Transmitter and, Edwin H. Colpitts, page 251.  
 Research, Scientific, Applied to the Telephone Transmitter and Receiver, Edwin H. Colpitts, page 251.



- Rice, S. O., Series for the Wave Function of a Radiating Dipole at the Earth's Surface, page 101.  
 Riordan, John, A Ladder Network Theorem, page 303.

S

- Samuel, A. L., A Negative Grid Triode Oscillator and Amplifier for Ultra-High Frequencies (a Digest), page 568.  
 Samuel, A. L. and N. E. Sowers, A Power Amplifier for Ultra-High Frequencies, page 10.  
 Schelkunoff, S. A. and T. M. Odarenko, Crosstalk between Coaxial Transmission Lines, page 144.  
 Short-Wave Reception, A Multiple Unit Steerable Antenna for, H. T. Friis and C. B. Feldman, page 337.  
 Sound Recording on Magnetic Tape, C. N. Hickman, page 165.  
 Sowers, N. E. and A. L. Samuel, A Power Amplifier for Ultra-High Frequencies, page 10.  
 Strieby, M. E., A Million-Cycle Telephone System, page 1.  
 Sundt, E. D., Currents and Potentials along Leaky Ground-Return Conductors (a Digest), page 110.  
 Sykes, R. A. and W. P. Mason, The Use of Coaxial and Balanced Transmission Lines in Filters and Wide-Band Transformers for High Radio Frequencies, page 275.

T

- Taylor C. C., Radio Telephone Noise Reduction by Voice Control at Receiver, page 475.  
 Telephone Circuits, The Inductive Coordination of Common-Neutral Power Distribution Systems and, J. O'R. Coleman and R. F. Davis, page 76.  
 Textiles, Moisture in, Albert C. Walker, page 228.  
 Toll Transmission in the United States, Recent Trends in, Edwin H. Colpitts, page 119.  
 Transmission, Toll, in the United States, Recent Trends in, Edwin H. Colpitts, page 119.  
 Transmitter and Receiver, Telephone, Scientific Research Applied to the, Edwin H. Colpitts, page 251.  
 Transoceanic Radio Telephone Development (a Digest), Ralph Bown, page 560.

V

- Vodas, The, S. B. Wright, page 456.

W

- Walker, Albert C., Moisture in Textiles, page 228.  
 Waterman, R. E., John Leutritz and Caleb M. Hill, A Laboratory Evaluation of Wood Preservatives, page 194.  
 Wave Function of a Radiating Dipole at the Earth's Surface, Series for the, S. O. Rice, page 101.  
 Wide-Band Transformers for High Radio Frequencies, The Use of Coaxial and Balanced Transmission Lines in Filters and, W. P. Mason and R. A. Sykes, page 275.  
 Wise, W. Howard, The Physical Reality of Zenneck's Surface Wave, page 35.  
 Wood Preservatives, A Laboratory Evaluation of, R. E. Waterman, John Leutritz and Caleb M. Hill, page 194.  
 Wrathall, L. R., E. Peterson and J. M. Manley, Magnetic Generation of a Group of Harmonics, page 437.  
 Wright, S. B., The Vodas, page 456.

Z

- Zenneck's Surface Wave, The Physical Reality of, W. Howard Wise, page 35.



